operating that all functions are sustained in effective cooperation. Not only do the different salts mutually offset each other's physiological deficiencies, but they are able to offset the usually harmful action of the solvent. Loeb has found an interesting experimental subject in *Fundulus,* a fish which is at home not only in the complete mixture, but which likewise survives for a time in distilled water. In the case of organisms which survive indefinitely in distilled water, it is likely that many do so largely by virtue of the salts contained in their own bodies. In general it appears that pure water extracts ions more or less rapidly from many plants and animals, and in case the experimental organism in question is of considerable size and the volume of water sufficiently limited the medium may easily get enough ions from the experimental plant or animal to offset the harmful action of the pure water. The ability of *Fundulus heteroclitus* to part with considerable quantities of salts to fresh water without immediately evident injury has been shown by Sumner. This fish is, however, hardly typical of marine organisms as a whole. In the red algæ, incomplete mixtures are injurious, as in *Fundulus,* but, unlike it, they are promptly killed by distilled water, which for them must be listed with the other constituents which, taken individually, act as fatal poisons. In this case, the mixture of salts is required to antagonize or efface the action of the water. A harmful action has been shown to characterize distilled water when used as a medium for various land plants as well, and to antagonize or efface this harmful action certain mixtures of salts, strikingly reminiscent of sea water in many important points, the so-called nutrient solutions, were long since devised by Knop, Sachs and others. It has been shown more recently by Osterhout and others that the so-called nutrient salts are toxic to land plants when taken individually in much greater dilution than has been generally supposed.

In both sea water and the more or less dilute nutrient solutions present in the soil, normal life is sustained as a rule only in mixtures of proper proportions and necessary concentration. Since salts are required in both cases to overcome the harmful action of pure water, as well as that of the salts themselves, there seems to be no reason to seek to limit the use of the term "balanced solutions" in the manner suggested by Loeb and Osterhout. Unless we admit that malnutrition due to a deficiency in nutrient salts is a form of toxicity excited by the substances present, we can hardly escape the alternative proposition that the missing salts are injurious *in absentia.*

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ON THE OSMOTIC PRESSURE OF THE JUICES OF DESERT PLANTS

IN 1907 Drabble and Drabble[1] argued from a series of plasmolyzations of the leaf cells of a number of British plants from a range of habitats that physiological dryness of the substratum is the primary factor in the determination of the osmotic strength of the contents of the leaf cells of flowering plants. About four years later Fitting[2] applied the plasmolytic method in an extensive reconnaissance physiological study of the vegetation of the rocky peaks and slopes of the Chaine de Sfa and the adjacent lowlands, comprising concentrated salt marsh and arable oasis. Here he reports some enormously high concentrations of cell sap, such indeed as would theoretically give pressures of over 100 atmospheres if confined in suitable semipermeable membranes surrounded by pure water.

The results of these two papers force upon one the conviction that observations of the concentration of the cell sap may form a legitimate, and indeed essential, feature of comprehensive and thoroughgoing ecological or phytogeographical study.

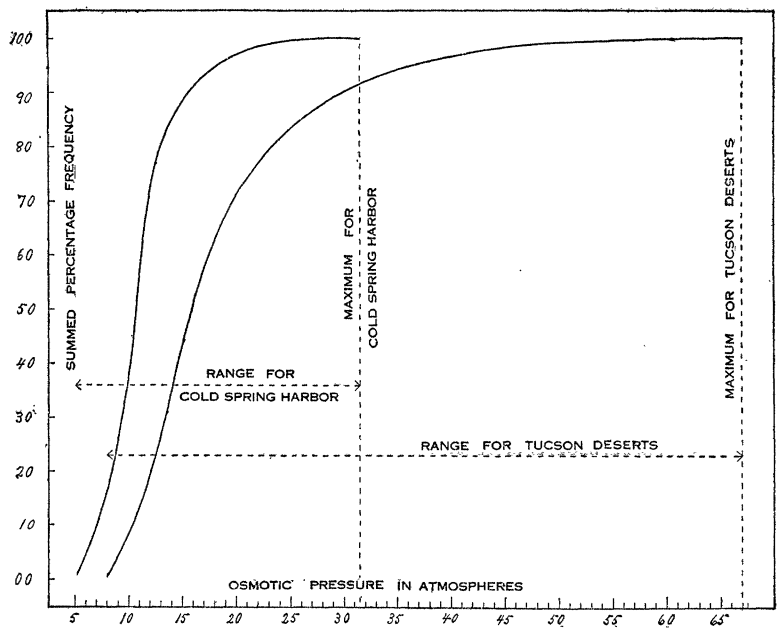
One must note, however, that the number of observations from each habitat studied by Drabble and Drabble was small, and that their maximum intensity of dryness was not very great. Again, there is no satisfactory series of determinations of the osmotic pressure of the sap of mesophytic plants to serve as a

[1] Drabble and Drabble, *Bio.-Chem. Jour.,* 2: 1907.

[2] Fitting, *Zeitschr. f. Bot.,* 3: 1911.

basis of comparison for Fitting's xerophytic series. Furthermore, both investigations were carried out by the use of plasmolytic methods, the accuracy of which when used under any but the most ideal conditions is open to some doubt.

Finally, the possibility of the existence within the living plant tissues of concentrations so high as these reported by Fitting has been questioned by plant physiologists.



Draughtsman's curves smoothing the summed percentage frequencies of osmotic pressures of various magnitudes in the sap of plants of the deserts around Tucson and from the various habitats near Cold Spring Harbor, Long Island.

It has therefore seemed to us highly desirable that further series of evidence should be gathered. Such data to be of real value should comprise extensive series of as nearly as possible comparable determinations from desert and moist regions. The technique which seemed to us the most trustworthy is the well-known freezing-point lowering method.

The director of the department of botanical research of the Carnegie Institution of Washington made it possible for two of us to carry out a series of cryoscopic determinations on the spring flora of the vicinity of Tucson, Arizona, during February, March and April, 1914. As a basis of comparison determinations on species of the spring and early summer native and naturalized flora of the vicinity of the Station for Experimental Evolution were made.[3] Each series comprised not far from two hundred determinations based on a large number of representative species. Cacti are excluded from the comparison because of known peculiarities.

The results will ultimately be published in detail. Preliminarily the differences between the two regions are most convincingly brought out by the accompanying diagrams. In these the actual frequencies of osmotic pressures[4] of various magnitudes have been

[3] The methods used were those already described (see Gortner and Harris, *Plant World,* 17: 1914), except for the fact that the freezing-point lowerings were determined by vaporization of ether in a Dewar vacuum tube jacket surrounding the freezing tube in which the bulb of the Beckmann thermometer was inserted.

[4] These are obtained directly from the depressions of the freezing point, corrected for super-

reduced to a percentage basis and these relative frequencies summed from the beginning for each successive grade. The curves are merely draughtsman's curves smoothing the empirical frequencies, but for present purposes they are quite good enough.

From such curves one may read off at once the relative frequencies of pressures of different grades. Thus for the Cold Spring Harbor series fifty per cent. of the pressures are about 10.5 atmospheres or lower, whereas in the Desert series fifty per cent. of the pressures are 15.7 atmospheres or higher. In the Tucson series about thirty per cent. of the concentrations are the equivalent of over 20 atmospheres, whereas in the Cold Spring Harbor series only about three per cent. of the cases exceed this value.

Note also that in the Desert there is a higher maximum and a higher minimum than in the more mesophytic habitat. The range of variation is also far greater in the Tucson than in the Cold Spring Harbor series.

In using cryoscopic methods we have so far failed to find pressures so high as those recorded by Fitting. We are not, however, ready to suggest that they do not occur. Possibly our failure to demonstrate them in the Tucson region may be due to the fact that our determinations were carried out at the close of the winter and spring rainy season, and hence on plants which had not been subjected to the maximum dryness of the region in question during the growing season of the year in which the determinations were made.

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cooling, by the use of tables already published. See Harris and Gortner, *Amer. Jour. Bot.*, 1: 1914.

ON THE GENUS TRACHODON[1]

In 1902 Mr. J. B. Hatcher published an article[2] entitled "The Genera and Species of the Trachodontidæ (Hadrosauridæ, Claosauridæ) Marsh," in which the conclusion was reached

> that the ten genera [of the Trachodontidæ] which have been proposed should be reduced to two. *Trachodon* Leidy and *Claosaurus* Marsh, while the remaining eight genera should be treated as synonyms of *Trachodon*, which should also be made to include *T.* (*Claosaurus*) *annectens* Marsh; while the smaller *Claosaurus agilis* described by Marsh from the Kansas chalks [Niobrara] may still be considered as pertaining to a distinct genus.''

These conclusions were almost unanimously adopted by American vertebrate paleontologists in their subsequent work, and this general use of the term *Trachodon* has continued up to the present time.

The finding of more perfect material in recent years has shown that several of the species formerly referred to *Trachodon* represent distinct genera, and in the light of these discoveries Hatcher's reduction now appears to have been too radical, but he was probably correct in restricting *Claosaurus* to the single species from the Niobrara formation.

It is unfortunate, however, that this view of the genus *Trachodon*, which includes species from the Judith River formation to the close of the Lance, has become so widely accepted by paleontologists.

In the first place the type of the genus (*Trachodon mirabilis* Leidy) is from the Judith River formation and was founded upon inadequate material consisting of "specimens of teeth generally very much worn and in a fragmentary condition," so that it is quite impossible to identify positively with them better and subsequently discovered specimens.

That later Hatcher[3] appreciated this fact is clearly shown by the following extract:

> Although the trachodonts are easily distinguishable by their teeth from the other Dinosauria of these beds [Judith River] it is scarcely possible to identify the various species of this genus or the genera of the family from the teeth alone.

Even though it eventually be found that

1 Published with the permission of the Director of the U. S. Geological Survey.

2 *Annals of the Carnegie Museum*, Vol. I., 1902, pp. 377–386.

3 T. W. Stanton and J. B. Hatcher, ''Geology and Paleontology of the Judith River Beds,'' Bull. 257, U. S. Geol. Surv., 1905, pp. 96–97.